

# World Oil Markets

*In the IEO2003 forecast, periodic production adjustments by OPEC members are not expected to have a significant long-term impact on world oil markets. Prices are projected to rise gradually through 2025 as the oil resource base is further developed.*

Throughout most of 2002, crude oil prices were solidly within the range preferred by producers in the Organization of Petroleum Exporting Countries (OPEC), \$22 to \$28 per barrel for the OPEC “basket price” (see Figure 14 on page 9). OPEC producers have been demonstrating disciplined adherence to announced cutbacks in production. Early in 2003, a dramatic upward turn in crude oil prices was brought about by a combination of two factors. First, a general strike against the Chavez regime resulted in a sudden drop in Venezuela’s oil exports. Although other OPEC producers agreed to increase production to make up for the lost Venezuelan output, the obvious strain on worldwide spare capacity kept prices high. Second, price volatility was exacerbated by fears of war in Iraq.

Although the labor turmoil in Venezuela appears to be ending, world oil prices are expected to remain near \$30 per barrel (for West Texas Intermediate crude oil, in nominal dollars) throughout most of 2003, mainly because of the war in Iraq and its aftermath. Due to differences in crude oil qualities, such a price is consistent with the lower portion of the OPEC price band. A softening of oil prices is anticipated in 2004 but is not expected to endure if OPEC maintains its recent successes in market management through production cutbacks. OPEC producers might find it more challenging to firm up oil prices over the next few years, however, given the expected increase in non-OPEC supply. They not only will have to demonstrate discipline within their own ranks but also may try to convince selected non-OPEC producers of the merits of production cutbacks. It remains to be seen whether such a coalition of OPEC and non-OPEC producers can demonstrate the restraint necessary to influence production objectives. Despite evidence that OPEC has achieved some of its price goals in recent years, production cutback strategies have historically had mixed success.

World oil consumption rose in 2002 by about 300 thousand barrels per day, scattered evenly among the industrialized nations (mainly North America) and developing nations (mainly Asia). Although the developing Asian economies are no longer in recession, their current growth is modest by comparison with their rapid economic expansion during the early and mid-1990s. Latin America’s oil demand has also shown only modest growth since 1999. In the former Soviet Union

(FSU), where oil demand grew in 2000 for the first time in more than a decade, there were slight increases in demand in both 2001 and 2002. In 2003, world oil demand is expected to grow by about 1.2 million barrels per day [1].

OPEC members have agreed to production increases that will add whatever volumes are necessary to replace the lost Venezuelan and Iraqi output. It is anticipated that the increases will somewhat temper any price escalation, but that uncertainty about post-war Iraq will keep the world oil price (U.S. refiner acquisition cost for imports) higher than market fundamentals might dictate.

OPEC’s recent successes have been the result of tight market conditions and disciplined participation by OPEC members. Currently, spare production capacity worldwide is low, and OPEC’s consensus building is easier as a result. Non-OPEC production is expected to show significant increases in the near future, however, and several members of OPEC have announced plans to expand production capacity over the next several years. In an oil market environment with substantial spare production capacity, it will be more difficult for OPEC to achieve unanimity among its members.

Although non-OPEC producers have been somewhat slow in reacting to higher oil prices, there remains significant untapped production potential worldwide, especially in deepwater areas. The lag between higher prices and increases in drilling activity seems to have increased in the aftermath of the low price environment of 1998 and 1999; nevertheless, non-OPEC production increased by 700 thousand barrels per day in 2001 and by an additional 1 million barrels per day in 2002, and it is expected to increase by an impressive 1.4 million barrels per day in 2003. Almost one-half of the total increase in non-OPEC production over the next 2 years is expected to come from the FSU. The remainder of the expected increase is evenly divided between producers in industrialized nations and those in developing economies.

Incorporating the recent price turbulence into the construction of an intermediate- and long-term oil market outlook is difficult and raises the following questions: Will prices remain in OPEC’s preferred range in response to production cutback strategies, or will the anticipated increase in non-OPEC production temper

the market? Will sustained and robust economic growth in developing countries return in the aftermath of the severe setback to the Asian economies in 1997-1999? Will new technology guarantee that oil supply development will move forward even if a low world oil price environment returns?

Although oil prices rose by almost \$10 per barrel over the course of 2002 and promise to go even higher in 2003, those developments are not indicative of the trend in the *International Energy Outlook 2003 (IEO2003)* reference case. In the short term, oil prices are expected to reflect the market uneasiness brought about by the war in Iraq. From anticipated high levels throughout 2003, oil prices are projected to decline significantly to \$23.27 in 2005 before rising by about 0.7 percent per year to \$26.57 in 2025 (all prices in 2001 dollars unless otherwise noted). When the economic recovery in Asia is complete, demand growth in developing countries throughout the world is expected to be sustained at robust levels. Worldwide oil demand is projected to reach almost 119 million barrels per day by 2025, requiring an increment to world production capability of more than 42 million barrels per day over current capacity. OPEC producers are expected to be the major suppliers of increased production, but non-OPEC supply is expected to remain competitive, with major increments to supply coming from offshore resources, especially in the Caspian Basin, Russia, Latin America, and deepwater West Africa.

Over the past 25 years, oil prices have been highly volatile. In the future, one can expect volatile behavior to recur principally because of unforeseen political and economic circumstances. It is well recognized that tensions in the Middle East, for example, could give rise to serious disruptions of normal oil production and trading patterns. On the other hand, significant excursions from the reference price trajectory are not likely to be sustained over long periods. High real prices deter consumption and encourage the emergence of significant competition from marginal but large sources of oil and other energy supplies; persistently low prices have the opposite effects.

Limits to long-term oil price escalation include substitution of other fuels (such as natural gas) for oil, marginal sources of conventional oil that become proved reserves (i.e., economically viable) when prices rise, and non-conventional sources of oil that become proved reserves at still higher prices. Advances in exploration and production technologies are likely to bring down prices when such additional oil resources become part of the reserve base. The *IEO2003* low and high world oil price cases suggest that the projected trends in growth for oil production are sustainable without severe oil price escalation. There are some oil market analysts, however, who find this viewpoint to be overly optimistic, based

on what they consider to be a significant overestimation of both proved reserves and ultimately recoverable resources.

Highlights of the *IEO2003* projections for the world oil market are as follows:

- The reference case oil price projection shows a dramatic increase from 2002 to 2003 as a result of the Venezuelan labor strike and the war in Iraq, a brief decline through 2005, and a modest 0.7-percent average annual increase out to 2025.
- Deepwater exploration and development initiatives are generally expected to be sustained worldwide, with the offshore Atlantic Basin emerging as a major future source of oil production in both Latin America and Africa. Technology and resource availability can sustain large increments in oil production capability at reference case prices. The low price environment of 1998 and early 1999 did slow the pace of development in some prospective areas, however, especially the Caspian Basin region.
- Economic development in Asia is crucial to the long-term growth of oil markets. The projected evolution of Asian oil demand in the reference case would strengthen economic ties between Middle East suppliers and Asian markets.
- Although OPEC's share of world oil supply is projected to increase significantly over the next two decades, competitive forces are expected to remain strong enough to forestall efforts to escalate real oil prices significantly. Competitive forces operate within OPEC, between OPEC and non-OPEC sources of supply, and between oil and other sources of energy (particularly natural gas).
- The uncertainties associated with the *IEO2003* reference case projections are significant. The war in Iraq, the international war on terrorism, uncertain economic recovery in developing Asia and Japan, the success of China's economic reforms and its political situation, the social unrest in Venezuela, Brazil's impact on other Latin American economies, and economic recovery prospects for the FSU all increase the risk of near-term political and policy discontinuities that could lead to oil market behavior quite different from that portrayed in the projections.

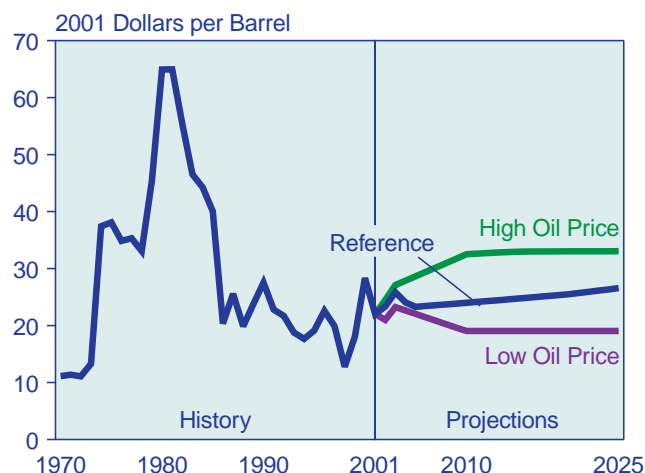
## World Oil Prices

The near-term price trajectory in the *IEO2003* reference case is considerably different from that in *IEO2002*. Last year's reference case price path did not reflect the upward price pressure in 2003 brought about by the situations in Iraq and Venezuela. In the longer term, oil prices in both the *IEO2003* and *IEO2002* reference cases

are projected to rise gradually over the last two decades of the forecast period; however, *IEO2003* projects average annual increases of 0.7 percent, as compared with 0.5 percent in the *IEO2002* forecast. The more robust price growth in the *IEO2003* reference case reflects the recognition that OPEC has been able to adhere to a production cutback strategy for the purpose of firming up prices. Three possible long-term price paths are shown in Figure 34. In the reference case, projected prices in 2001 dollars reach \$26.57 in 2025. (In nominal dollars, the reference case price is expected to exceed \$48 in 2025.) In the low price case, prices are projected to reach \$19.04 by 2009 and to remain at about that level out to 2025. In the high price case, prices are projected to reach \$32.95 by 2015 and to remain at about that level out to 2025. The leveling off in the high price case results from projected market penetration of alternative energy supplies that could become economically viable at that price level.

In all the *IEO2003* oil price cases, oil demand is expected to rise significantly over the projection period. The projected rise in oil consumption ranges from a low of 36 million barrels per day in the high price case to a high of 48 million barrels per day in the low price case. There is widespread agreement that resources are not a key constraint on world demand to 2025. Rather more important are the political, economic, and environmental circumstances that could shape developments in oil supply and demand.

**Figure 34. World Oil Prices in Three Cases, 1970-2025**



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** 2002-2003—EIA, *Short-Term Energy Outlook*, on-line version (April 2003), web site [www.eia.doe.gov/emeu/steo/pub/contents.html](http://www.eia.doe.gov/emeu/steo/pub/contents.html). 2003-2025—EIA, *Annual Energy Outlook 2003*, DOE/EIA-0383 (2003) (Washington, DC, January 2003).

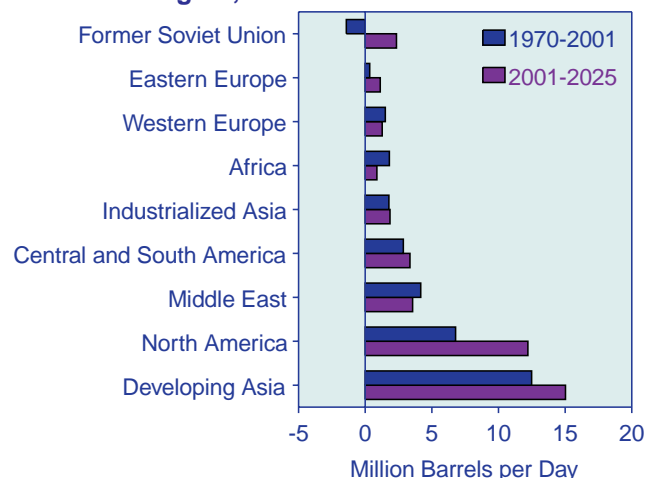
## World Oil Demand

World oil demand is projected to grow to 119 million barrels per day by 2025 in the *IEO2003* reference case. Over the forecast period, oil remains the fuel of choice in the transportation sector worldwide, and almost three-quarters of the projected increase in oil demand from 2001 to 2025 comes from the transportation sector, particularly in developing countries that currently have a lower proportion of transportation fuels in their energy mix.

During the outlook period, global economic growth, the main driver of oil demand growth, is expected to average 3.1 percent per year. The highest rates of economic growth from 2001 to 2025 are expected in developing Asia, led by China and India at 6.2 percent and 5.2 percent, respectively. As a result, the developing countries' share of world oil demand is projected to increase from 36 percent in 2001 to 43 percent in 2025, with a corresponding drop in the industrialized countries' share from 57 percent in 2001 to 50 percent in 2025. In absolute terms (Figure 35), the largest regional increases in oil demand are projected for North America (12.2 million barrels per day) and developing Asia (15.0 million barrels per day).

The smallest increase is projected for Western Europe, where transportation and other end-use infrastructures are more mature and population growth is relatively slow. Even so, the large amount of oil used for transportation in Western Europe ensures that oil will continue to be the dominant fuel used in Europe, accounting for

**Figure 35. Increments in Oil Consumption by Region, 1970-2001 and 2001-2025**



Sources: **1970 and 2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **2025:** EIA, *System for the Analysis of Global Energy Markets* (2003).

more than 39 percent of primary energy use in the reference case forecast.

## North America

North America is the largest consumer of oil in the world, accounting for more than one-fourth of total demand in 2001 (Figure 36). Oil consumption in the transportation sector currently represents 66 percent of North America's total oil demand. That share is expected to continue to increase as oil use declines in other end-use sectors (for example, natural gas is expected to displace most oil use for electricity generation).

Among the different refined petroleum products consumed, the strongest growth in demand in North American oil markets is projected for gasoline. In contrast, jet fuel consumption, estimated at 1.9 million barrels per day in 2001, has been declining in the wake of airline industry troubles since 2000 and the September 11, 2001, terrorist attacks in New York and Washington, DC, using civilian airplanes. When the prices of jet fuel reached a peak at the end of 2000, many carriers added fuel charges to their ticket and cargo prices. Jet fuel prices eased in 2001, weakened by the U.S. economic slowdown, but new security measures are now becoming an important cost component for airlines that may further depress demand growth.

Oil demand in the United States is projected to grow by 1.7 percent per year to 29.2 million barrels per day in 2025 from 19.6 million barrels per day in 2001. Most of the growth is projected for the transportation sector, with cars and light truck fleets—including sport utility vehicles (SUVs)—being the largest consuming segment

of the sector. The airlines industry is expected to be struggling for the next 5 years before positive growth in jet fuel demand resumes for the rest of the outlook period.

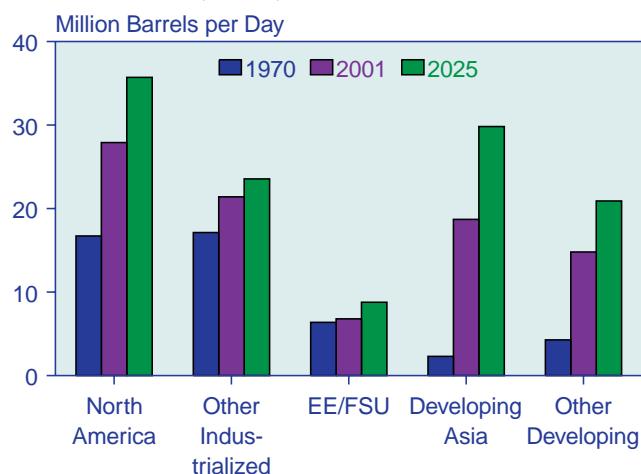
In 2002, U.S. automakers began offering generous financing deals for SUVs and other passenger vehicles to bolster demand levels. SUVs now form a distinctive part of the U.S. landscape. There were a reported 66 SUV/sport wagon models on sale in the United States during 2001, and some estimates expect that number to rise to more than 80 models by 2005. Some other estimates suggest that the SUV share of the U.S. market could rise by 40 percent over the next 5 years, with the market share for crossover vehicles—which share some characteristics of the station wagon segment—possibly rising by as much as 58 percent [2].

Despite their popularity with the public, SUVs remain a controversial choice of vehicle because of their relatively low fuel economies. Ironically, some observers point to the original introduction of corporate average fuel economy (CAFE) standards during the 1970s as being instrumental in pushing automakers toward building SUVs. With those standards allowing average fuel economy of 27.5 miles per gallon for cars and 20.7 miles per gallon for light truck fleets, automakers claim that they were unable to build larger sedans for bigger families and, instead, sought refuge by building up their product mixes towards light trucks. The comparatively low prices of both vehicles and vehicle fuels in the United States as compared with much of the rest of the world have allowed SUVs to remain sufficiently economical for U.S. consumers to buy and run—far more so than in Western Europe, for example.

As in the United States, the transportation sector is the major source of oil demand growth in the Canadian market; however, the Canadian federal government ratified the Kyoto Protocol in December 2002 and is moving to introduce regulations that could slow the trend. In the *IEO2003* reference case, oil demand in Canada is expected to grow by 1 percent per year on average, to 2.4 million barrels per day in 2025.

In Mexico, long-term economic growth is expected to remain strong at 5.2 percent per year over the forecast period; however, many of the reforms needed for such growth to materialize probably will not happen in the short to mid-term [3]. Over the long term, Mexico's closeness to the U.S. economy and its participation in the North America Free Trade Agreement (NAFTA) are two major factors that should enable the country to continue on its path toward economic modernization. Oil demand in Mexico is projected to grow by 3.2 percent per year, from 1.9 million barrels per day in 2001 to 4.1 million barrels per day in 2025.

**Figure 36. World Oil Consumption by Region, 1970, 2001, and 2025**



Sources: **1970 and 2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **2025:** EIA, System for the Analysis of Global Energy Markets (2003).



## Western Europe

A decade of mediocre economic growth and the penetration of natural gas have acted to constrain overall oil consumption in Western Europe, except in the transportation sector. Oil demand in Western Europe is projected to grow by only 0.4 percent per year, from 14 million barrels per day in 2001 to 15.3 million barrels per day in 2025, with little or no increase in the United Kingdom, Germany, France, and Italy.

Demand for diesel fuel in Western Europe has grown by 50 percent since 1990, while gasoline demand has declined marginally. Future growth in diesel demand may be constrained, however, in light of the controversial findings linking possible carcinogenic properties of particulate emissions to the burning of diesel fuel. In addition, the ratification of the Kyoto Protocol by Western European countries through the European Union reflects a general consensus over questions related to climate change, in which the vast majority of the projected growth of carbon dioxide emissions will come from the transportation sector [4]. In the *IEO2003* reference case, oil remains the dominant fuel used in Western Europe, but its share of total primary energy consumption shrinks from 42 percent in 2001 to 39 percent in 2025.

## Industrialized Asia

In industrialized Asia, oil demand is expected to grow more rapidly in Australia and New Zealand than in Japan. Oil use in Australia and New Zealand is projected to grow by 2.3 percent per year, from 1 million barrels per day in 2001 to 1.7 million barrels per day in 2025, reflecting higher expectations for population growth and economic expansion. In Japan, the projected increase averages only 0.8 percent per year, from 5.4 million barrels per day in 2001 to 6.5 million barrels per day in 2025. In absolute terms, oil consumption in New Zealand is lower than that in Australia or Japan; however, moderate improvements in New Zealand's economic growth outlook are accompanied by a higher projected growth rate for oil demand through 2025 [5].

In 2002, Japan's oil demand fell for the third consecutive year. Demand for fuel oil by large industries and electric utilities continued to fall as a result of Japan's prolonged economic recession. Between September and December 2002, there was an unexpected increase (some 130 thousand barrels per day) in demand for fuel oil in Japan's electricity sector as a result of a series of nuclear reactor shutdowns [6]. Operation of as many as 17 nuclear reactors (totaling more than 12,300 megawatts of capacity) has been suspended pending safety inspections, after manipulation of inspection data that began in the mid-1980s was uncovered [7]. This is expected to be a temporary aberration, and nuclear generation is expected to regain its share of the Japanese electricity market in the near future.

## Eastern Europe and the Former Soviet Union

In the *IEO2003* reference case, total oil demand in the FSU and Eastern Europe is projected to reach 7.9 million barrels per day in 2020 (2.2 million barrels per day less than projected in *IEO2002*) and 8.8 million barrels per day in 2025.

The lack of oil resources in Eastern Europe, in contrast to the abundance of coal, has limited the share of oil in the energy mix to an estimated 26 percent in 2001. Oil demand in Eastern Europe—mainly for use in the transportation sector—is projected to grow by 2.5 percent per year, to 2.5 million barrels per day in 2025, rising to about 29 percent of total energy consumption.

Poland, the largest economy in Eastern Europe and a candidate for membership in the European Union in 2004, received the greatest amount of regional investment in the 1990s. Its economy has slowed over the past 2 years, however, leading to high unemployment, rising interest rates, and falling demand for oil. Still, however, Poland arguably offers the greatest potential for future growth in oil demand in the Eastern Bloc in terms of potential market size. The person per car ratio is 4.2 in Poland, which is much higher than in many other countries in Europe (for example, Germany at about 1.7 and the Czech Republic at about 2.8 persons per car) [8]. The high ratio in Poland indicates room for expansion in the automotive market and related demand for transportation fuels.

Strong economic growth has continued for the past 5 years in hydrocarbon-oriented economies such as Russia, Kazakhstan, Azerbaijan, and Turkmenistan, supported by high earnings from oil and gas exports and continued foreign investment. In the *IEO2003* reference case, GDP growth in the FSU countries is projected to average 3.8 percent per year from 2001 to 2025, and oil demand is expected to grow by 2 percent per year, from 3.9 million barrels per day in 2001 to 6.2 million barrels per day in 2025.

The transportation sector, particularly trucking, is expected to be the major source of oil demand growth in the FSU region. Also, given the huge geographical expanse of Russia, the largest economy in the region, a continued increase in demand for air travel, and as a result demand for jet fuel, can be expected to continue with rising personal incomes. Apart from the transportation sector, oil demand in the FSU continues to decline in the power generation and industrial sectors, mainly because of improvements in efficiency and substitution of natural gas for fuel oil.

## Developing World

In the *IEO2003* reference case, oil demand in the developing world is projected to reach 50.7 million barrels per

day by 2025. In developing Asia, India's growth in oil demand has slowed substantially in recent years, and the high growth rate of the 1990s is not expected to be sustained over the next two decades, as India moves further toward less oil-intensive economic activities, such as services and information technology.

Developing Asia has managed to avoid the global slump of 2001 through robust regional economic growth, strong consumer confidence, low interest rates, and progressive liberalization of trade. Demand for road transportation fuels, in particular, is surging ahead to pre-Asia crisis levels of 1998. This trend is projected to continue, led by China and India, the two largest economies in the region. Oil demand in developing Asia is projected to reach 29.8 million barrels per day in 2025.

### **China**

Oil demand has continued to climb in China with increasing motorization and switching away from coal and traditional, noncommercial fuels in the residential and service sectors. Oil demand in China is projected to grow by 3.3 percent per year on average, from 5 million barrels per day in 2001 to 10.9 million barrels per day in 2025. Most of the additional oil will have to be imported.

In 2001, vehicle ownership in China was 13 vehicles per 1,000 persons, as compared with 779 per 1,000 in the United States. China's accession to the World Trade Organization in 2001 is expected to increase competition in the automobile sector, stimulating passenger car sales and demand for transportation fuels. Car prices are expected to fall by around 15 percent as a result of increased competition from imports. China's road system is still failing to keep up with growth in vehicle use, however, and its major cities already face gridlock. In addition to poor road infrastructure, China has a lack of parking facilities. The government carried out massive infrastructure development in 2002, involving 251 highway projects covering 16,104 miles, at a cost of \$ 4.1 billion [9]. The government plans for all counties in undeveloped western China to have access to a highway by the end of the year.

With strong growth in automobile use throughout the country, the Chinese government has also become increasingly concerned about air quality, particularly in urban areas. In preparation for the Beijing Olympics in 2008, the Chinese government is planning to phase out leaded gasoline and has pledged to replace 1.8 million outdated vehicles [10].

### **India**

India's GDP growth rates of 5 to 7 percent, sustained over several years, have been better than anywhere in the world except China. They have been achieved without the massive social dislocation that threatens stability

in China and parts of Southeast Asia and were sustained throughout the financial shocks that hit Southeast Asia in 1997 [11]. India's GDP growth is projected to average 5.2 percent per year from 2001 to 2025, and oil demand is projected to grow by 4 percent per year, from 2.1 million barrels per day in 2001 to 5.5 million barrels per day in 2025. About 70 percent of the increase in oil demand is projected for the transportation sector. The Indian government plans to spend \$12.5 billion upgrading existing roads and constructing two East-West and North-South highways that will span the country by the end of 2003 [12]. India's roads sector is believed to be among the fastest growing infrastructure areas in the country. On the other hand, the impact of high oil prices in 2000 and 2001, the drought that weakened oil demand in the agricultural sector, the massive earthquake that struck the prosperous state of Gujarat in January 2001, and the devastating monsoon (the first in a decade) in 2002 have made sustaining the high oil demand growth registered during the 1990s difficult to achieve over the past 2 years.

Diesel fuel has historically been much cheaper than gasoline in India. A substantial rise in gasoline prices in 1976 led to the conversion of almost all commercial vehicles to diesel engines. The continuous increase in gasoline prices and the subsidy provided to diesel progressively increased demand for diesel commercial vehicles; however, a recent drive against diesel and greater use of compressed natural gas (CNG) seems to be having some impact. The Delhi Transport Department was ordered by a Supreme Court directive to convert from diesel fuel to CNG by April 2001, in an attempt to reduce pollution from diesel-fueled buses. The decision caused public transport chaos and angry demonstrations in New Delhi. The Supreme Court extended the deadline for the diesel ban several times, but in April 2002 it stood firm, forcing the Delhi government to pull around 6,000 diesel buses off the roads or face hefty fines, and causing commuter chaos in the city. India's two major bus manufacturers benefitted from the decision, which forced the local government to purchase around 1,000 new CNG-fueled buses [13]. Other cities are following suit.

India's demand for oil in the form of naphtha for electric power generation has grown at a phenomenal rate over the past decade [14]. In the long run, however, demand for naphtha in the power generation and industrial sectors is projected to decline, with natural gas claiming a larger share of the energy mix.

### **South Korea**

South Korea consumed 2.1 million barrels of oil per day in 2001, compared with 1 million barrels per day in 1990. It is likely that the country will experience continued growth in oil demand, but at a slower rate than in the

1990s, as its transportation sector grows more slowly, pressures for greater energy efficiency increase, and the economy moves away from reliance on heavy industrial production.

Oil demand in South Korea fell drastically in 2001 as the result of an economic downturn. In 2002, economic recovery was apparent in the country, and oil demand was expected to begin rising as a result of stronger GDP and, to some extent, the surge in tourism that accompanied the World Cup soccer games in Seoul [15]. Oil demand in South Korea is projected to grow by 1.8 percent per year in the *IEO2003* reference case, reaching 3.3 million barrels per day in 2025. The transportation sector is expected to account for most of the increase, as demand growth slows in the industrial sector and remains flat in the residential and commercial sectors, where consumers are expected to continue switching to natural gas.

South Korea wants to use more CNG and less diesel fuel in its transportation sector. The government has announced a plan that would replace 20,000 diesel charter buses, 7,800 cross-country buses, and 2,200 express buses with CNG vehicles. About 10 percent of South Korea's metropolitan buses have already converted to CNG [16]. The Korean Ministry of Environment has not announced a decision on any clean-diesel option, which would include the ultra-low-sulfur diesel used during the World Cup soccer tournament in 2002.

#### Other Developing Asia

Oil demand in other developing Asia is projected to grow by 2.6 percent per year, from 5.5 million barrels per day in 2001 to 10.2 million barrels per day in 2025. Many poor countries in the region still depend heavily on biomass energy. The need to switch from biomass to petroleum products as the region's national economies grow will ensure that petroleum product consumption will grow substantially during the forecast period. In addition, market liberalization measures, such as the lowering of import tariffs within the Association of Southeast Asian Nations (ASEAN) Free-Trade Area (AFTA) are providing a further boost to the competitive economic environment and oil demand growth.

#### Middle East

Oil demand in the Middle East is projected to grow at an average annual rate of 2.1 percent, from 5.4 million barrels per day in 2001 to 8.9 million barrels per day in 2025. Growth in the region's oil consumption is expected to be tempered by aggressive moves into natural gas development and utilization being made by a number of countries. Oil's share in the energy mix was about 53 percent in 2001 and is projected to remain near that level through 2025. Coal, nuclear, and hydropower supplies in the region are limited, and the prospects for their development are minimal given the availability of oil and gas.

Nevertheless, Iran is in the process of commissioning the Bushehr nuclear reactor, which was started in the 1970s, with the assistance of Russian expertise [17]. The reactor is expected to be completed by the end of 2004.

Iran and Saudi Arabia, the two largest oil consumers in the Middle East, each surpassed the million barrel per day consumption mark in the 1990s. Iran's domestic consumption of oil totaled at 1.5 million barrels per day in 2002, representing more than one-third of its oil production capacity [18]. The growth in demand for oil in Iran is supported by a large working-age population and heavily subsidized prices for transportation fuels.

In Saudi Arabia, the transportation sector and the massive petrochemical sector have been driving rapid growth in oil demand—mainly in the form of gasoline, diesel, liquefied petroleum gas (LPG), and naphtha—since the mid-1990s. Direct burning of crude oil in the power generation sector still takes place in Saudi Arabia, although the government plans to eliminate the practice before 2015. That will require Saudi Arabia to use 2.6 billion cubic feet per day of additional natural gas [19]. The Saudi government has launched a Strategic Gas Initiative, in which major oil companies (ExxonMobil and Shell) have been invited to explore and develop gas reserves that will feed five power plants and three desalination units, as well as petrochemical plants (see box on page 66 in the Natural Gas chapter).

Turkey, the largest economy in the Middle East, is struggling in the aftermath of its economic crisis, which began in February 2001 and left interest rates soaring. Over the forecast period, Turkey's economy is projected to grow by 4 percent per year, and its demand for oil is projected to grow by 3.1 percent per year, from 0.6 million barrels per day in 2001 to 1.3 million barrels per day in 2025.

#### Africa

In the past decade many African countries have introduced economic reforms under pressure from multilateral lending institutions [20]. Those reforms have started to show positive effects in the economy of the region, which in turn will encourage further growth in oil demand, particularly in the transportation sector. Oil demand in the power generation, industrial, and residential sectors is likely to remain relatively low due to the availability of alternatives to oil. South Africa, the largest economy in the region, is highly dependent on coal and will soon expand its use of gas with the startup of imports from Mozambique. During the outlook period, oil demand in Africa as a whole is projected to grow by 1.2 percent per year, to 3.5 million barrels per day in 2025.

#### Central and South America

*IEO2003* projects stronger growth for oil demand in the developing world than in the industrial world but



weaker growth than was projected in *IEO2002* projection. In particular, expectations for growth in Central and South America have been substantially lowered because of financial setbacks in Argentina and political unrest in Venezuela.

The lack of domestic savings, with the exception of Chile, is a significant limiting factor for potential economic growth in Central and South America. Many countries are in danger of serious economic turmoil in the face of their crippling debt-servicing requirements. In 2002, oil demand was hardest hit in Argentina, which plunged into depression after the country's economic collapse in December 2001. Fuel prices in Argentina have nearly doubled in 2002 after the devaluation of the local peso currency, causing sharp contraction of oil demand [21]. Colombia, Venezuela, and Uruguay all have tipped into recession, and investors have shied away from Brazil, the region's largest economy, fearing that the new, left-leaning government might reverse past privatization efforts.

The share of oil in total primary energy demand declined in Central and South America over the past decades with the development of large hydropower projects. Oil still accounts for one-half of the region's total energy use, however, and few new large-scale hydropower opportunities are expected to be developed over the forecast period. *IEO2003* projects that oil's share will decline slowly to 45 percent in 2025, mainly due to competition from natural gas in the electricity generation and industrial sectors. Oil demand in Central and South America is projected to grow by 2.1 percent per year, to 8.5 million barrels per day in 2025.

## The Composition of World Oil Supply

In the *IEO2003* reference case, world oil supply in 2025 is projected to exceed the 2001 level by 41 million barrels per day. Increases in production are expected for both OPEC and non-OPEC producers; however, only about 39 percent of the total increase is expected to come from non-OPEC areas. Over the past two decades, the growth in non-OPEC oil supply has resulted in an OPEC market share substantially under its historic high of 52 percent in 1973. New exploration and production technologies, aggressive cost-reduction programs by industry, and attractive fiscal terms to producers by governments all contribute to the outlook for continued growth in non-OPEC oil production.

While the long-term outlook for non-OPEC supply remains optimistic, the low oil price environment of 1998 and early 1999 had a definite impact on exploration and development activity. By the end of 1998, drilling activity in North America had fallen by more than 25 percent from its level a year earlier. Worldwide, only the

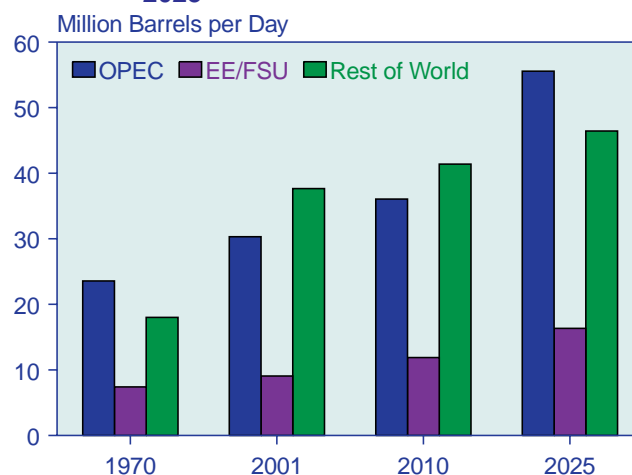
Middle East region registered no decline in drilling activity during 1998. In general, onshore drilling fell more sharply than offshore drilling. Worldwide, offshore rig utilization rates were generally sustained at levels better than 80 percent of capacity [22].

The reference case projects that about 61 percent of the increase in petroleum demand over the next two decades will be met by an increase in production by members of OPEC rather than by non-OPEC suppliers. OPEC production in 2025 is projected to be more than 25 million barrels per day higher than it was in 2001 (Figure 37). The *IEO2003* estimates of OPEC production capacity to 2005 are slightly less than those projected in *IEO2002*, reflecting a shift toward non-OPEC supply projects in the recent high price environment. Some analysts suggest that OPEC might pursue significant price escalation through conservative capacity expansion decisions rather than undertake ambitious production expansion programs; however, the low and high world oil price forecasts in this outlook do not assume such suggestions.

## Reserves and Resources

Table 11 shows estimates of the conventional oil resource base by region out to the year 2025. Proved reserves are from the annual assessment of worldwide reserves published by *Oil & Gas Journal*. Reserve growth and undiscovered estimates are based on the *World Petroleum Assessment 2000* by the U.S. Geological Survey (USGS). The oil resource base consists of three categories: remaining proved reserves (oil that has been discovered but not produced); reserve growth (increases in proved reserves that occur over time as oil fields are

**Figure 37. World Oil Production in the Reference Case by Region, 1970, 2001, 2010, and 2025**



Sources: **1970 and 2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219 (2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **2010 and 2025:** EIA, System for the Analysis of Global Energy Markets (2003).



developed, produced, and are the beneficiaries of technological improvements; and undiscovered (oil that remains to be found through new field exploration). The information in Table 11 is derived from the USGS mean estimate, an average assessment over a wide range of uncertainty for reserve growth and undiscovered resources. The *IEO2003* oil production forecast is based on the USGS mean assessment.

### Expansion of OPEC Production Capacity

It is generally acknowledged that OPEC members with large proved reserves and relatively low costs for expansion of production capacity can accommodate sizable increases in petroleum demand. In the *IEO2003* reference case, the production call on OPEC suppliers is projected to grow at a robust annual rate of 2.5 percent through 2025 (Table 12 and Figure 38). OPEC capacity utilization is expected to increase sharply after 2001, reaching 95 percent by 2015 and remaining there through 2025.

Amidst enormous uncertainty, Iraq's role in OPEC in the next several years will be of particular interest. In the *IEO2003* reference case, Iraq is assumed to maintain its

**Table 11. Estimated World Oil Resources, 2000-2025**  
(Billion Barrels)

Region and Country	Proved Reserves	Reserve Growth	Undiscovered
<b>Industrialized</b>			
United States .....	22.45	76.03	83.03
Canada .....	180.02	12.48	32.59
Mexico .....	12.62	25.63	45.77
Japan .....	0.06	0.09	0.31
Australia/New Zealand...	3.52	2.65	5.93
Western Europe .....	18.10	19.32	34.58
<b>Eurasia</b>			
Former Soviet Union ....	77.83	137.70	170.79
Eastern Europe .....	1.53	1.46	1.38
China .....	18.25	19.59	14.62
<b>Developing Countries</b>			
Central and South America .....	98.55	90.75	125.31
India .....	5.37	3.81	6.78
Other Developing Asia...	11.35	14.57	23.90
Africa .....	77.43	73.46	124.72
Middle East .....	685.64	252.51	269.19
<b>Total .....</b>	<b>1,212.88</b>	<b>730.05</b>	<b>938.90</b>
<b>OPEC .....</b>	<b>819.01</b>	<b>395.57</b>	<b>400.51</b>
<b>Non-OPEC .....</b>	<b>393.87</b>	<b>334.48</b>	<b>538.39</b>

Note: Resources include crude oil (including lease condensates) and natural gas plant liquids.

Source: U.S. Geological Survey, *World Petroleum Assessment 2000*, web site <http://greenwood.cr.usgs.gov/energy/WorldEnergy/DDS-60>.

current oil production capacity of 3.1 million barrels per day into 2003. Iraq has indicated a desire to expand its production capacity aggressively, to about 6 million barrels per day, once the sanctions are lifted. Preliminary discussions of exploration projects have already been held with potential outside investors. Such a large increase in Iraqi oil exports would offset a significant portion of the price stimulus associated with the expected growth in oil demand.

Given the requirements for OPEC production capacity expansion implied by the *IEO2003* estimates, much attention has been focused on the oil development,

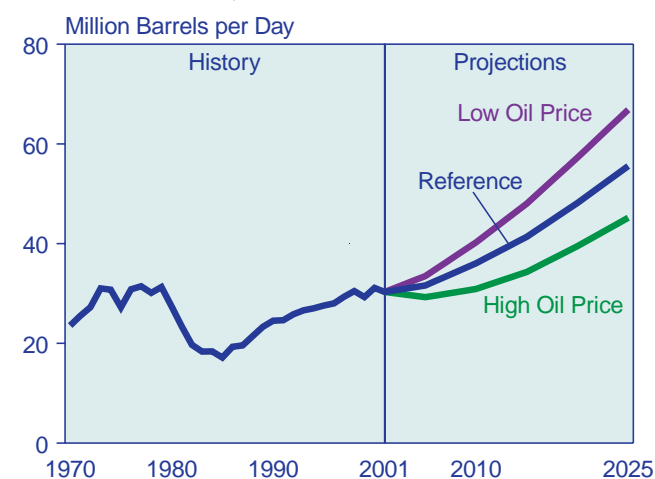
**Table 12. OPEC Oil Production, 1990-2025**  
(Million Barrels per Day)

Year	Reference Case	High Oil Price	Low Oil Price
<b>History</b>			
1990 .....	24.5	—	—
2001 .....	30.3	—	—
<b>Projections</b>			
2005 .....	31.6	29.3	33.5
2010 .....	36.1	30.9	40.2
2015 .....	41.4	34.3	48.0
2020 .....	48.2	39.5	57.3
2025 .....	55.6	45.2	66.9

Note: Includes the production of crude oil, natural gas plant liquids, refinery gain, and other liquid fuels.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2003).

**Figure 38. OPEC Oil Production in Three Oil Price Cases, 1970-2025**



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2003).

production, and operating costs of individual OPEC producers. With Persian Gulf producers enjoying a reserve-to-production ratio that exceeds 89 years, substantial capacity expansion clearly is feasible.

Production costs in Persian Gulf OPEC nations are less than \$2 per barrel, and the capital investment required to increase production capacity by 1 barrel per day is less than \$5,600 [23]. Assuming the *IEO2003* low price trajectory, total development and operating costs over the entire projection period, expressed as a percentage of gross oil revenues, would be less than 21 percent. Thus, Persian Gulf OPEC producers can expand capacity at a cost that is a relatively small percentage of projected gross revenues.

For OPEC producers outside the Persian Gulf, the cost to expand production capacity by 1 barrel per day is considerably greater, exceeding \$12,700 in some member nations; yet those producers can expect margins in excess of 34 percent on investments to expand production capacity over the long term, even in the low price case [24]. Venezuela has the greatest potential for capacity expansion and could aggressively increase its production capacity by more than 1.0 million barrels per day, to 4.2 million barrels per day by 2005. It is unclear, however, whether the current political climate in Venezuela will support the outside investment required for any substantial expansion of production capacity. Tables D1-D6 in Appendix D show the ranges of production potential for both OPEC and non-OPEC producers.

The reference case projection implies aggressive efforts by OPEC member nations to apply or attract investment capital to implement a wide range of production capacity expansion projects. If those projects were not undertaken, world oil prices could escalate; however, the combination of potential profitability and the threat of competition from non-OPEC suppliers argue for the pursuit of a relatively aggressive expansion strategy.

In the *IEO2003* forecast, OPEC members outside the Persian Gulf are expected to increase their production potential substantially, despite their higher capacity expansion costs. There is much optimism regarding Nigeria's offshore production potential, although it is unlikely to be developed until the middle to late part of this decade. In addition, increased optimism about the production potential of Algeria, Libya, and Venezuela supports the possibility that the growth in world dependence on Persian Gulf oil will slow.

**Non-OPEC Supply**

The growth in non-OPEC oil supplies played a significant role in the erosion of OPEC's market share over the past two decades, as non-OPEC supply became increasingly diverse. North America dominated non-OPEC supply in the early 1970s, the North Sea and Mexico

evolved as major producers in the 1980s, and much of the new production in the 1990s has come from the developing countries of Latin America, West Africa, the non-OPEC Middle East, and China. In the *IEO2003* reference case, non-OPEC supply from proved reserves is expected to increase steadily, from 46.7 million barrels per day in 2001 to 62.8 million barrels per day in 2025 (Table 13).

There are several important differences between the *IEO2003* production profiles and those published in *IEO2002*:

- The U.S. production decline is somewhat less severe in the *IEO2003* projections as a result of higher oil price paths, technological advances yielding higher recovery rates, and lower costs for deepwater exploration and production in the Gulf of Mexico.
- The expected decline in North Sea production is slightly tempered, due to higher oil price paths coupled with enhanced subsea and recovery technologies.
- Resource development in the Caspian Basin region was expected to be delayed significantly in the *IEO2002* forecast due to significant geopolitical challenges and an expected lower price environment. In the *IEO2003* projections, Caspian output is expected to rise to almost 2.5 million barrels per day by 2005 and to increase steadily thereafter. There still remains a great deal of uncertainty about export routes from the Caspian Basin region.
- IEO2002* anticipated moderate delays in the exploration and development of deepwater projects worldwide. Significant output from such projects was not anticipated until oil prices returned to and remained

**Table 13. Non-OPEC Oil Production, 1990-2025**  
(Million Barrels per Day)

Year	Reference Case	High Oil Price	Low Oil Price
<b>History</b>			
1990 .....	42.2	—	—
2001 .....	46.7	—	—
<b>Projections</b>			
2005 .....	49.1	50.2	47.8
2010 .....	53.3	55.1	51.2
2015 .....	57.0	59.6	54.1
2020 .....	59.6	63.2	55.6
2025 .....	62.8	67.8	58.1

Note: Includes the production of crude oil, natural gas plant liquids, refinery gain, and other liquid fuels.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2003).

in the range of \$22 to \$28 per barrel for a significant period of time. With higher world oil price assumptions, output from deepwater projects in the U.S. Texas Gulf, the North Sea, West Africa, the South China Sea, Brazil, Colombia, and the Caspian Basin is accelerated in the *IEO2003* forecast by 2 to 3 years.

In the *IEO2003* forecast, the decline in North Sea production is slowed as a result of substantial improvement in field recovery rates. Production from Norway, Western Europe's largest producer, is expected to peak at about 3.4 million barrels per day in 2004 and then gradually decline to about 2.5 million barrels per day by the end of the forecast period with the maturing of some of its larger and older fields. The United Kingdom sector is expected to produce about 2.5 million barrels per day by the middle of this decade, followed by a decline to 1.4 million barrels per day by 2025.

Two non-OPEC Persian Gulf producers are expected to increase output gradually over the first half of this decade. Enhanced recovery techniques are expected to increase output in Oman by more than 160,000 barrels per day, with only a gradual production decline anticipated after 2005. Current oil production in Yemen is expected to increase by at least 90,000 barrels per day in the next several years, and those levels should show little decline throughout the forecast period. Syria is expected to hold its production flat throughout this decade, but little in the way of new resource potential will allow anything except declining production volumes.

Oil producers in the Pacific Rim are expected to increase their production volumes significantly as a result of enhanced exploration and extraction technologies. India is expected to show some modest production increase early in this decade and only a modest decline in output thereafter. Deepwater fields offshore from the Philippines have resulted in an improved reserve picture; by the middle of this decade, their production is expected to reach almost 55,000 barrels per day. Vietnam is still viewed with considerable optimism regarding long-term production potential, although exploration activity has been slower than originally hoped. Output levels from Vietnamese fields are expected to exceed 415,000 barrels per day by 2025.

Australia has made significant recent additions to its proved reserves, and it is possible that Australia will become a one million barrel per day producer by the middle of this decade. Malaysia shows little potential for any significant new finds, and its output is expected to peak at around 800,000 barrels per day early in this decade and then gradually decline to 680,000 barrels per day by 2025. Papua New Guinea continues to add to its reserve posture and is expected to achieve production volumes approaching 150,000 barrels per day by the middle of this decade, followed by only a modest

decline over the remainder of the forecast period. Exploration and test-well activity have pointed to some production potential for Bangladesh and Myanmar, but significant output is not expected until late in this decade.

Oil producers in Central and South America have significant potential for increasing output over the next decade. Brazil became a million barrel per day producer in 1999, with considerable production potential waiting to be tapped. Brazil's production is expected to rise throughout the forecast period and to top 3.9 million barrels per day by 2025. Colombia's current economic downturn and civil unrest have delayed development of its upstream sector, but its output is expected to top 650,000 barrels per day within the decade and then show a modest decline for the remainder of the forecast period. In both countries, the oil sector would benefit significantly from the creation of a favorable climate for foreign investment.

Argentina is expected to increase its production volumes by at least 150,000 barrels per day over the next 2 years, and by the middle of the decade it is capable of becoming a million barrel per day producer. Although the current political situation in Ecuador is in transition, there is still optimism that Ecuador will increase production by more than 350,000 barrels per day within the next few years.

Several West African producers (Angola, Cameroon, Chad, Congo, Gabon, and Ivory Coast) are expected to reap the benefits of substantial exploration activity, especially considering the recent rebound in oil prices. Angola is expected to become a million barrel per day producer early in this decade. Given the excellent exploration results, Angola could produce volumes of up to 3.2 million barrels per day well into the later years of the forecast period. The other West African producers with offshore tracts are expected to increase output by up to 1 million barrels per day for the duration of the forecast.

North African producers Egypt and Tunisia produce mainly from mature fields and show little promise of adding to their reserve posture. As a result, their production volumes are expected to decline gradually throughout the forecast. Sudan and Equatorial Guinea are expected to produce significant volumes by the middle of this decade. Both could approach 500,000 barrels per day. Eritrea, Mauritania, Somalia, and South Africa also have some resource potential, but they are not expected to produce significant amounts until after 2005.

In North America, moderately rising U.S. output is expected to be complemented by significant production increases in Canada and Mexico. Canada's conventional oil output is expected to increase by more than 200,000 barrels per day over the next 2 years, mainly from



Newfoundland's Hibernia oil project, which could produce more than 155,000 barrels per day at its peak sometime in the next several years. Canada is projected to add an additional 500,000 barrels per day in output from a combination of frontier area offshore projects and oil from tar sands (see box below). Higher expected oil prices, technological advances, and lower costs for deep-water exploration and production in the Gulf of Mexico enhance the long-term U.S. production profile. Mexico is

expected to adopt energy policies that will encourage the efficient development of its resource base. Expected production volumes in Mexico exceed 4.2 million barrels per day by the end of the decade and remain near that level through 2025.

With assumed higher oil prices, oil production in the FSU is expected to exceed 10 million barrels per day by 2005. The long-term production potential for the FSU is

### And the Country with the Second Greatest Proved Oil Reserves Worldwide Is . . .

Six months ago, "Iraq" was the correct completion of the above phrase. Its 112.5 billion barrels of proved oil reserves was second only to Saudi Arabia's imposing 259.3 billion barrels. However, in the December 23, 2002, issue of the *Oil & Gas Journal*, proved oil reserves in Canada catapulted from an estimated 4.9 billion barrels in 2002 to an amazing 180 billion barrels in 2003. How was this possible? A methodology change by the *Oil & Gas Journal* now includes western Canada's oil sands in its definition of proved oil reserves. Heretofore, oil sands were considered "nonconventional" and were not counted as proved oil reserves; however, dramatic reductions in development and production costs have brought oil sands into the realm of economic viability. With today's technologies and oil prices, it is entirely appropriate to consider western Canada's vast oil potential as being commensurate with "conventional" crude oils.<sup>a</sup>

How much is there? It is estimated that there are about 1.7 trillion barrels of oil in the oil sands of Canada, and that about 15 percent (255 billion barrels) of the total oil in place is recoverable. Canada accounts for about 75 percent of the world's oil sand resources. Other countries and regions that have significant, but more modest, resources include the United States, China, the EE/FSU, the Caribbean Basin, and Pakistan. About 700 thousand barrels per day of Canadian oil sands are currently being produced. This supply is divided into two categories, "oil sands in situ" (often referred to as bitumen) and "oil sands mining." These two categories reflect the method of recovery. The bitumen is extracted by injecting very hot steam into the rock formation to heat up the oil, lower its viscosity, and allow it to flow more like conventional oil. Slightly more than half (about 400 thousand barrels per day) of Canadian oil sands production is derived from the more expensive "oil sands mining" method. Those deposits that are close enough to the surface are actually mined.

How much does recovery from oil sands cost? Supply costs are expressed as "full cycle" costs. They include all costs associated with exploration, development, and

production; capital costs; operating costs; taxes and royalties; and a 10-percent real rate of return to the producer. Capital costs average \$5 to \$9 per barrel, and operating costs average \$8 to \$12 per barrel. Such costs are presented as a range, reflecting the variance in reservoir quality, depth, project size, and operating parameters. The remainder of the supply cost is dominated by the cleaning and upgrading methods that are required to turn a very low quality hydrocarbon into a more conventional oil that can be accepted by a refinery. Such methods include the removal of sulfur, heavy metals, and noncombustible materials, as well as conversion to a more hydrogenated and lighter hydrocarbon. These costs are typically in the \$3 to \$5 per barrel range. None of the aforementioned costs include transportation to market. This past summer, Suncor Energy opened the upgrading units of its Millennium Project in Alberta with production costs around \$9 per barrel. The company's near-term goal is to lower production costs to \$5.50 per barrel, which would make Suncor the lowest-cost oil producer in North America.<sup>b</sup>

What is the long-term outlook for production from oil sands? *IEO2003* projects that Canadian oil sand production in the reference case will increase to more than 2.2 million barrels per day by 2025. The projection assumes that world oil prices will moderate in the next few years and gradually increase to over \$26.50 per barrel (all prices expressed in 2001 dollars) by the end of the forecast period. The *IEO2003* high oil price case (over \$33 per barrel by 2025) shows Canadian oil sand production increasing to almost 2.5 million barrels per day by 2025. The only thing that prevents Canadian oil sands production from being considerably higher (both now and in the future) is the lack of transportation infrastructure (most likely pipeline capacity) for moving production to market. The United States is expected to import almost 1 million barrels per day of production from Canadian oil sands by 2025. If potential pipeline projects from Western Canada into PADDs II and IV materialize over the next two decades, the share of Canadian oil sand production going to U.S. imports could grow substantially.

<sup>a</sup>"Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 100, No. 52 (December 23, 2002), pp. 114-115.

<sup>b</sup>National Energy Board, *Canada's Oil Sands: A Supply and Market Outlook to 2015* (Calgary, Alberta, October 2000), pp. 34-40.

still regarded with considerable optimism, especially for the resource-rich Caspian Basin region. The *IEO2003* reference case shows FSU output exceeding 15.9 million barrels per day by 2025, implying export volumes exceeding 6.7 million barrels per day. In China, oil production is expected to decline slightly to about 3.4 million barrels per day by 2025. China's import requirements are expected to be as large as its domestic production by 2012 and to continue growing as its petroleum consumption increases.

The *IEO2003* estimates for non-OPEC production potential are based on such parameters as numbers of exploration wells, finding rates, reserve-to-production ratios, advances in both exploration and extraction technologies, and sensitivity to changes in the world oil price. A critical component of the forecasting methodology is the constraint placed on the exploration and development of non-OPEC undiscovered resources. For the purpose of the three *IEO2003* price cases, no more than 15, 25, and 35 percent of the mean USGS estimate of non-OPEC undiscovered oil is assumed to be developed over the forecast period in the low price, reference, and high price cases, respectively. In all the oil price cases, OPEC producers are assumed to be the source of the required residual supply. Tables D1-D6 in Appendix D show the ranges of production potential for both OPEC and non-OPEC producers.

The expectation in the late 1980s and early 1990s was that non-OPEC production in the longer term would stagnate or decline gradually in response to resource constraints. The relatively insignificant cost of developing oil resources in OPEC countries (especially those in the Persian Gulf region) was considered such an overwhelming advantage that non-OPEC production potential was viewed with considerable pessimism. In actuality, however, despite a relatively low price environment, non-OPEC production has risen every year since 1993, adding more than 5.8 million barrels per day between 1993 and 2001.

It is expected that non-OPEC producers will continue to increase output, producing an additional 6.6 million barrels per day by 2010. Three factors are generally given credit for the impressive resiliency of non-OPEC production: development of new exploration and production technologies, efforts by the oil industry to reduce costs, and efforts by producer governments to promote exploration and development by encouraging outside investors with attractive fiscal terms.

## Worldwide Petroleum Trade in the Reference Case

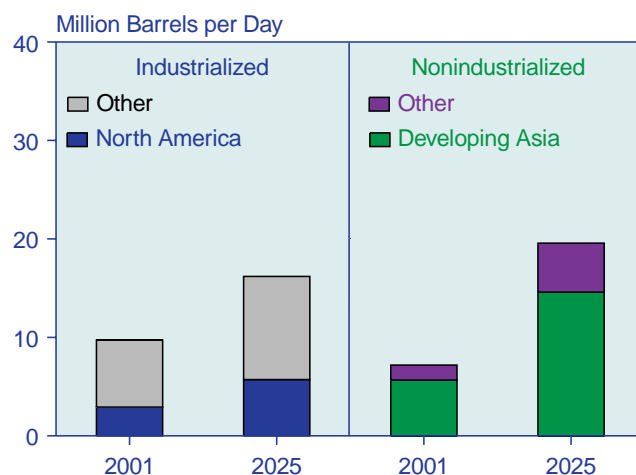
In 2001, industrialized countries imported 16.1 million barrels of oil per day from OPEC producers. Of that total, 9.7 million barrels per day came from the Persian

Gulf region. Oil movements to industrialized countries represented almost 65 percent of the total petroleum exported by OPEC member nations and almost 58 percent of all Persian Gulf exports (Table 14). By the end of the forecast period, OPEC exports to industrialized countries are estimated to be about 11 million barrels per day higher than their 2001 level, and more than half the increase is expected to come from the Persian Gulf region.

Despite such a substantial increase, the share of total petroleum exports that goes to the industrialized nations in 2025 is projected to be almost 5 percent below their 2001 share, and the share of Persian Gulf exports going to the industrialized nations is projected to fall to about 12 percent. The significant shift expected in the balance of OPEC export shares between the industrialized and developing nations is a direct result of the economic growth anticipated for the developing nations of the world, especially those of Asia. OPEC petroleum exports to developing countries are expected to increase by more than 16.8 million barrels per day over the forecast period, with three-fourths of the increase going to the developing countries of Asia. China, alone, is likely to import about 5.9 million barrels per day from OPEC by 2025, virtually all of which is expected to come from Persian Gulf producers.

North America's petroleum imports from the Persian Gulf are expected to almost double over the forecast period (Figure 39). At the same time, more than one-half of total North American imports in 2025 are expected to be from Atlantic Basin producers and refiners, with significant increases expected in crude oil imports from Latin American producers, including Venezuela, Brazil,

**Figure 39. Imports of Persian Gulf Oil by Importing Region, 2001 and 2025**



Sources: **2001:** Energy Information Administration (EIA), *International Energy Annual 2001*, DOE/EIA-0219(2001) (Washington, DC, February 2003), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **2025:** EIA, Office of Integrated Analysis and Forecasting, *IEO2003 WORLD Model run IEO2003.B25* (2003).

Colombia, and Mexico. West African producers, including Nigeria and Angola, are also expected to increase their export volumes to North America. Caribbean Basin refiners are expected to account for most of the increase in North American imports of refined products.

With a moderate decline in North Sea production, Western Europe is expected to import increasing amounts from Persian Gulf producers and from OPEC member nations in both northern and western Africa. Substantial imports from the Caspian Basin are also expected. Industrialized Asian nations are expected to increase their already heavy dependence on Persian Gulf oil. The developing countries of the Pacific Rim are expected to almost double their total petroleum imports between 2001 and 2025.

Worldwide crude oil distillation refining capacity was about 81.2 million barrels per day at the beginning of 2002. To meet the projected growth in international oil demand in the reference case, worldwide refining capacity would have to increase by more than 40 million barrels per day by 2025. Substantial growth in distillation capacity is expected in the Middle East, Central and South America, and especially in the Asia Pacific region. Refiners in North America and Europe, while making only modest additions to their distillation capacity, are expected to continue improving product quality and enhancing the usefulness of the heavier portion of the barrel through investment in downstream capacity. Likewise, future investments by developing countries are also expected to include more advanced configurations designed to meet the anticipated increase in demand for lighter products, especially transportation fuels.

**Table 14. Worldwide Petroleum Trade in the Reference Case, 2001 and 2025**  
(Million Barrels per Day)

Exporting Region	Importing Region								Total Exports
	Industrialized				Nonindustrialized				
	North America	Western Europe	Asia	Total	Pacific Rim	China	Rest of World	Total	
2001									
OPEC									
Persian Gulf . . . . .	2.9	2.7	4.1	9.7	4.8	0.9	1.5	7.2	16.9
North Africa . . . . .	0.4	2.0	0.0	2.3	0.2	0.0	0.0	0.2	2.6
West Africa . . . . .	0.9	0.6	0.0	1.5	0.7	0.0	0.1	0.8	2.2
South America . . . . .	1.8	0.2	0.2	2.2	0.1	0.0	0.3	0.4	2.6
Asia . . . . .	0.1	0.0	0.3	0.4	0.2	0.0	0.0	0.2	0.7
<b>Total OPEC . . . . .</b>	<b>6.1</b>	<b>5.5</b>	<b>4.6</b>	<b>16.1</b>	<b>6.0</b>	<b>0.9</b>	<b>1.9</b>	<b>8.8</b>	<b>24.9</b>
Non-OPEC									
North Sea . . . . .	0.6	4.5	0.0	5.2	0.0	0.0	0.0	0.0	5.2
Caribbean Basin . . . . .	0.6	0.1	0.0	0.7	0.1	0.0	0.1	0.1	0.8
Former Soviet Union . . . . .	0.2	3.6	0.3	4.2	0.2	0.0	0.1	0.3	4.5
Other Non-OPEC . . . . .	5.5	3.6	1.2	10.3	3.7	1.1	5.7	10.5	20.8
<b>Total Non-OPEC . . . . .</b>	<b>6.9</b>	<b>11.8</b>	<b>1.6</b>	<b>20.4</b>	<b>4.0</b>	<b>1.1</b>	<b>5.8</b>	<b>11.0</b>	<b>31.4</b>
<b>Total Petroleum Imports . . .</b>	<b>13.0</b>	<b>17.3</b>	<b>6.2</b>	<b>36.5</b>	<b>10.0</b>	<b>2.0</b>	<b>7.8</b>	<b>19.7</b>	<b>56.3</b>
2025									
OPEC									
Persian Gulf . . . . .	5.7	4.5	6.0	16.2	9.4	5.2	5.0	19.6	35.8
North Africa . . . . .	0.4	2.9	0.0	3.4	0.6	0.2	0.6	1.4	4.8
West Africa . . . . .	1.2	1.0	0.3	2.5	1.8	0.3	0.1	2.2	4.7
South America . . . . .	4.3	0.3	0.1	4.7	0.4	0.0	0.3	0.7	5.4
Asia . . . . .	0.1	0.0	0.2	0.3	1.5	0.2	0.1	1.8	2.1
<b>Total OPEC . . . . .</b>	<b>11.8</b>	<b>8.7</b>	<b>6.7</b>	<b>27.1</b>	<b>13.6</b>	<b>5.9</b>	<b>6.0</b>	<b>25.6</b>	<b>52.7</b>
Non-OPEC									
North Sea . . . . .	0.7	3.4	0.0	4.0	0.1	0.0	0.2	0.3	4.3
Caribbean Basin . . . . .	2.5	0.4	0.1	3.0	0.5	0.0	1.0	1.5	4.5
Former Soviet Union . . . . .	0.8	4.9	0.8	6.5	0.6	1.4	1.4	3.4	9.9
Other Non-OPEC . . . . .	12.6	2.8	0.6	16.0	4.4	0.4	2.5	7.3	23.3
<b>Total Non-OPEC . . . . .</b>	<b>16.5</b>	<b>11.5</b>	<b>1.5</b>	<b>29.5</b>	<b>5.5</b>	<b>1.8</b>	<b>5.1</b>	<b>12.5</b>	<b>42.0</b>
<b>Total Petroleum Imports . . .</b>	<b>28.3</b>	<b>20.2</b>	<b>8.1</b>	<b>56.6</b>	<b>19.1</b>	<b>7.8</b>	<b>11.2</b>	<b>38.1</b>	<b>94.6</b>

Notes: Totals may not equal sum of components due to independent rounding.

Sources: **2001:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2025:** EIA, Office of Integrated Analysis and Forecasting, IEO2003 WORLD Model run IEO2003.B25 (2003).



## Other Views of Prices and Production

Several oil market analysis groups produce world oil price and production forecasts. Table 15 compares the *IEO2003* world oil price projections with similar forecasts from the International Energy Agency (IEA), Petroleum Economics, Ltd. (PEL), Petroleum Industry Research Associates (PIRA), Altos Partners (Altos), Energy and Environmental Analysis, Inc. (EEA), Natural Resources Canada (NRCan), Global Insight, Inc. (GII), and Deutsche Banc Alex.Brown (DBAB).

The collection of forecasts includes a wide range of price projections, based on the volatility of the world oil markets. In particular, oil prices have fluctuated widely since the late 1990s, first tumbling as a result of the Asian economic recession of 1997-1998, then climbing with the region's subsequent recovery. High oil prices followed the ability of OPEC to maintain production quotas in 2000, which supported sustained high prices throughout the year. Finally, oil prices collapsed in mid- to late 2001 as a result of decreases in demand that accompanied the global economic slowdown and the aftermath of the September 11 terrorist attacks but recovered during 2002 as a result of unrest in the Middle East, disruption of Venezuela's oil exports, a colder than expected winter in North America, and low storage levels in the United States. By the first quarter of 2003, oil prices had neared \$40 per barrel (nominal dollars).

The current oil price projections for 2005 range from PEL's \$21.21 per barrel (constant 2001 U.S. dollars) to *IEO2003*'s \$23.27 per barrel. The NRCan forecast is the earliest: NRCan's projection was originally formulated in 1997 (but reaffirmed in 2002). Nevertheless, NRCan's forecast falls well within the range defined by the other forecasts. Five of the eight forecasts—GII, IEA, PEL, DBAB, and EEA—fall below the range defined by the *IEO2003* high and low world oil price cases in 2005, demonstrating the volatility of the oil markets in the wide range of price projections in this early year of the forecast.

The PEL price forecast series may be considered an outlier relative to the rest of the forecasts. It is the only series among the set of forecasts that is based on Brent oil prices; they fall consistently below those of the *IEO2003* low price path through 2015, when the PEL time series ends. If the PEL series is omitted, the range of prices among the remaining series is much smaller in 2015, \$7 per barrel, with PIRA at the high end of the range (\$26.32 per barrel) and DBAB at the low end (\$19.34 per barrel). At the end of the forecast period, the uncertainty among the forecasters as measured by the difference between highest and lowest expected prices climbs to \$12.43 per barrel, with the range defined by the Altos (\$31.61 per barrel) and DBAB (\$19.18 per barrel) forecasts.

The *IEO2003* price projections are generally at the high end of the spectrum of price forecasts across the

**Table 15. Comparison of World Oil Price Projections, 2005-2025**  
(2001 Dollars per Barrel)

Forecast	2005	2010	2015	2020	2025
<i>IEO2003</i>					
Reference Case . . . . .	23.27	23.99	24.72	25.48	26.57
High Price Case . . . . .	28.65	32.51	32.95	33.02	33.05
Low Price Case . . . . .	22.04	19.04	19.04	19.04	19.04
Altos . . . . .	22.64	23.40	25.58	27.90	31.61
GII . . . . .	20.80	21.70	23.76	25.39	—
IEA . . . . .	21.47	21.47	23.52	25.56	27.61
PEL . . . . .	21.21	18.46	17.47	—	—
PIRA . . . . .	22.43	23.33	26.32	—	—
NRCan . . . . .	22.28	22.28	22.28	22.28	—
DBAB . . . . .	19.04	18.94	19.34	19.07	19.18
EEA . . . . .	20.98	20.47	19.98	19.50	—

Notes: *IEO2003* projections are for average landed imports to the United States. Altos, PIRA, and NRCan projections are for West Texas Intermediate crude oil at Cushing. GII, DBAB, and EEA projections are for composite refiner acquisition prices. IEA projections are for IEA crude oil import price. PEL projections are for Brent crude oil.

Sources: **IEO2003**: Energy Information Administration, *Annual Energy Outlook 2003*, DOE/EIA-0383(2003) (Washington, DC, January 2003). **Altos**: Altos Partners, World Oil Model, e-mail from Tom Choi (October 9, 2002). **GII**: Global Insight, Inc., *U.S. Energy Price Outlook, Autumn/Winter 2002* (Lexington, MA, December 2002), p. 12. **IEA**: International Energy Agency, *World Energy Outlook 2002* (Paris, France, September 2002), p. 39. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, June 2002), p. 47. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2002), Table II-3. **NRCan**: Natural Resources Canada, *Canada's Energy Outlook, 1996-2020, Annex C2* (Ottawa, Ontario, Canada, April 1997) (reaffirmed in August 2002). **DBAB**: Deutsche Banc Alex.Brown, Inc., "World Oil Supply and Demand Estimates," e-mail from Adam Sieminski (January 17, 2003). **EEA**: Energy and Environmental Analysis, Inc., EEA Compass Service: October 2002 Base Case.

2005-2025 time period, with a few exceptions. PIRA's \$26.32 price forecast for 2015 is higher than the *IEO2003* estimate of \$24.72. The Altos forecasts for 2015-2025 are higher than the *IEO2003* reference case projections, as are the IEA price estimates for 2020 and 2025. It should be noted that IEA did not publish a price projection for 2015 or 2025 in its *World Energy Outlook 2002*; however, it states that "prices are assumed to rise in a linear fashion after 2010," from \$21.47 per barrel in 2010 to \$29.65 per barrel in 2030. A simple interpolation results in oil prices in 2015 of about \$23.52 per barrel and in 2025 of \$27.61 per barrel, placing the IEA prices slightly below the *IEO2003* estimate of \$24.72 per barrel in 2015 but above the *IEO2003* estimate in 2025.

The Altos price projections follow a particularly steep upward path over the 2005 to 2025 time horizon. Whereas the Altos prices in 2005 are \$0.63 per barrel lower than those in the *IEO2003* reference case, by 2015 they are \$0.86 per barrel higher than the *IEO2003* prices. By 2025, the Altos prices are \$5.04 per barrel higher than the *IEO2003* projection.

The price forecasts are influenced by differing views of the projected composition of world oil production. Two factors are of particular importance: (1) expansion of OPEC oil production and (2) the timing of a recovery in EE/FSU oil production. All the forecasts agree that the recovery of EE/FSU production will be fairly slow, although most are somewhat more optimistic about EE/FSU production development than they were last year.

High world oil prices in 2002 and into the first part of 2003, along with accelerating economic recovery in Russia, currently the largest oil producer in the EE/FSU region, no doubt have influenced the production forecasts for the EE/FSU. Nevertheless, only DBAB projects that the share of EE/FSU production will rise above 15 percent over the course of the projection period. DBAB estimates that EE/FSU production will rise to 18 percent of total world oil supply by 2025 (Table 16). GII is the least optimistic about recovery in the region, and its projected share for the EE/FSU remains at 11 percent throughout the 2005-2025 time period. The other four production forecasts expect the EE/FSU share of world oil production to vary between 13 and 15 percent. *IEO2003* projects that the EE/FSU share of production will reach 14 percent of the world total in 2015 and remain at that level through 2025.

The forecasts that provide projections through 2020 (*IEO2003*, GII, DBAB, and IEA) all expect OPEC to provide incremental production of between 17 and 20 million barrels per day between 2001 and 2020 (Table 16). There is more variation in expectations among these four forecasts for the "other" non-OPEC suppliers. GII expects a substantial increase of 13.1 million barrels per

day of supply from other suppliers, whereas IEA expects a decline of 5.0 million barrels per day in production from other non-OPEC sources. IEA projects that the "other" share of world oil production will fall to 31 percent by 2020 while the OPEC share increases to 48 percent. In contrast to GII, *IEO2003* expects more moderate growth in other non-OPEC supply, at 8.0 million barrels per day from 2001 to 2020. DBAB expects growth of 3.5 million barrels per day.

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**Table 16. Comparison of World Oil Production Forecasts**

Forecast	Percent of World Total			Million Barrels per Day			
	OPEC	EE/FSU	Other Non-OPEC	OPEC	EE/FSU	Other Non-OPEC	Total
<b>History</b>							
2001 .....	39	13	48	30.4	9.8	37.1	<b>77.0</b>
<b>Projections</b>							
<b>2005</b>							
<i>IEO2003</i> .....	39	12	48	31.6	10.0	39.1	<b>80.7</b>
GII <sup>a</sup> .....	37	10	49	30.6	8.7	40.6	<b>83.2</b>
PEL .....	37	13	47	30.4	10.3	38.4	<b>81.1</b>
PIRA .....	34	13	53	28.4	10.5	43.5	<b>82.4</b>
DBAB .....	37	14	47	30.1	11.4	37.7	<b>80.8</b>
<b>2010</b>							
<i>IEO2003</i> .....	40	13	46	36.1	11.9	41.3	<b>89.3</b>
GII <sup>a</sup> .....	38	11	48	34.7	10.0	44.5	<b>89.1</b>
IEA <sup>b</sup> .....	40	14	39	35.9	12.7	35.1	<b>88.9</b>
PEL .....	40	13	45	35.6	11.6	39.7	<b>89.1</b>
PIRA .....	35	15	50	32.1	13.3	46.1	<b>91.5</b>
DBAB .....	41	16	41	36.5	14.1	36.4	<b>89.1</b>
<b>2015</b>							
<i>IEO2003</i> .....	42	14	44	41.4	13.6	43.4	<b>98.4</b>
GII <sup>a</sup> .....	38	11	47	39.3	11.5	48.2	<b>102.6</b>
PEL .....	46	13	39	44.4	12.7	37.6	<b>97.0</b>
PIRA .....	38	15	47	37.5	15.3	46.7	<b>99.5</b>
DBAB .....	42	17	39	41.5	16.3	38.1	<b>98.3</b>
<b>2020</b>							
<i>IEO2003</i> .....	45	14	42	48.2	14.8	44.8	<b>107.8</b>
GII <sup>a</sup> .....	42	11	44	47.3	12.0	49.9	<b>112.7</b>
IEA <sup>b</sup> .....	48	13	31	50.2	13.9	31.8	<b>104.1</b>
DBAB .....	43	17	37	46.9	18.9	40.3	<b>108.7</b>
<b>2025</b>							
<i>IEO2003</i> .....	47	14	39	55.6	16.3	46.4	<b>118.3</b>
DBAB .....	45	18	35	54.3	21.9	42.0	<b>121.1</b>

<sup>a</sup>In the GII projections, EE/FSU includes only Russia.

<sup>b</sup>IEA total supply numbers include processing gains and unconventional oil. As a result, regional percentages do not add to 100.

Note: IEA, GII, PEL, and DBAB report processing gains separately from regional production numbers. As a result, the percentages attributed to OPEC, EE/FSU, and Other Non-OPEC do not add to 100.

Sources: **IEO2003**: Energy Information Administration, System for the Analysis of Global Energy Markets (2003). **GII**: Global Insight, Inc., *Oil Market Outlook: Long-Term Focus, Spring/Summer 2002* (Lexington, MA, 2002), p. 30. **IEA**: International Energy Agency, *World Energy Outlook 2002* (Paris, France, September 2002), p. 96. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, June 2002), p. 47. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2002), Table II-3. **DBAB**: Deutsche Banc Alex.Brown, Inc., "World Oil Supply and Demand Estimates," e-mail from Adam Sieminski (January 17, 2003).



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